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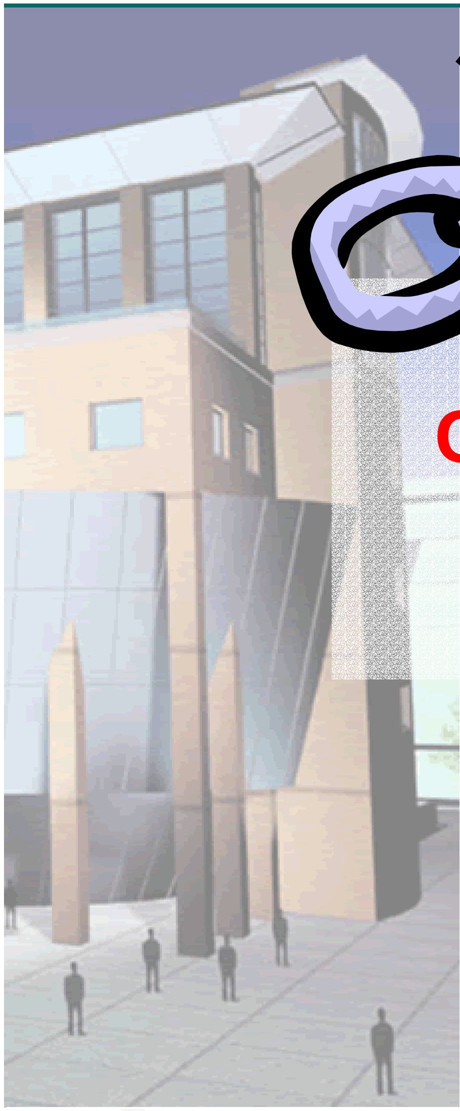

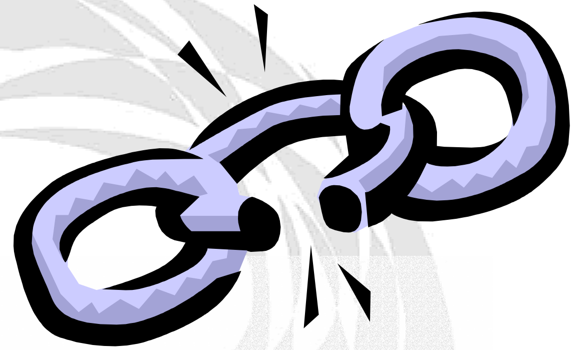

# Critical Chain Project Management: High Potential - Hard to Achieve

January 28, 2005


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# Known Problems

**Deming and Rummler, Brache**

It's the system, stupid!

"Pit a good person against a bad system and the system will win all the time."

*Rummler and Brache, 2002*

# Deming's 85/15

- 85% of faults are process related, and it is management's responsibility to solve them
- 15% of faults are the responsibility of
- individual employee's
- Most time management is focusing on the "15" rather than the "85", trying to find the guilty person rather than to improve the process

*Deming, W.E., "Out of the Crisis", MIT, CIA, Massachussetts, 1986*

# Known Problems

## Impact of Resource Allocation Problems

**Samples: USA: 172 Projects (112 succ., 50 fail.)**
**GER: 448 Projects (257 succ., 191 fail.)**

| Correlation Coefficients | Resource Conflicts | |
|---|---|---|
| Success Criteria | GER | USA |
| Efficiency | -.20 | -.26 |
| Effectiveness | -.15 | -.19 |
| Customer Satisfaction | -.21 | -.21 |
| Business Results | -.20 | -.19 |
| MEANS | 4.4 | 4.1 |

- **Many projects suffer under resource conflicts**
- **Resource conflicts have negative impact**

# Known Problems

## CPM Limitations

- **CPM resource allocation leads to minimal single project duration (local optimum)**
- **CPM does not maximize the throughput of a multi-project system (global optimum)**
- **CPM does not explicitly take variation (risk) into account**

**Critical Path Method leads to sub-optimal resource allocation!**

# Known Problems

## Solution Critical Chain

**Critical Chain**

**Provides a systems approach for managing multiple projects sharing a set of resources**

- **Improved system throughput (global optimum)**

**Explicitly takes variation (risk) into account**

- **Efficiently! (reduces time to market)**

**Provides a visible, and powerful way to manage risk and likelihood of on-time delivery**

- **A base for real risk management (reduces % of late projects)**

**Critical Chain promises advantages over CPM!**

# Overview

- **Known Problems**
- **What is CC?**
- **CC Performance Impact**
- **Case Study ABC Ltd.**
- **CC Implementation Problems**
- **CC Implementation Concept**
- ***CC-Lite* Outlook**

# What is CC?

## Critical Chain vs. CPM

**Traditional PM scheduling problems:**

- Resource conflicts
- Delays
- Uncertainty (scope change, context, resources)

**CC offers a solution:**

- Performance improvement with same resource base
- Reduces resource conflicts
- Reduces uncertainty
- Addresses multi-project environments

# What is CC?

## Critical Chain vs. CPM

**Critical Chain three level approach:**

1. Philosophical Level: Theory of Constraints
2. Multi-Project Level: Systems Approach
3. Single-Project Level: Managing Variation

**Critical Path one level approach:**

1. Single Project Level: Managing Due Date
   Does not account for variation
   Does not account for behaviors
   Does not account for multi-project system

**Critical Chain promises advantages over CPM!**

# What is CC?

## Philosophical Level: ToC

**Theory of Constraints:**

1. Systems perspective
2. Focus on the system's bottle neck
3. Throughput mindset
4. Avoid sub-optimization
5. Use simple tools

Eli Goldratt, "The Goal," 1988

# What is CC?

## Single-Project Level

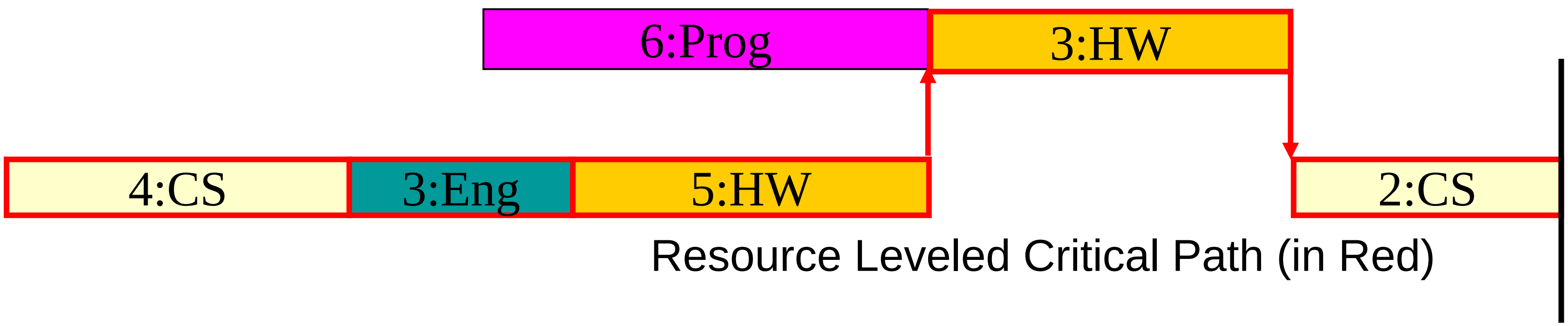
Critical Chain computation steps for single project schedule:

- Compute baseline schedule using average activity times
- Aggregate safety margins into Project Buffer
- Identify critical chain, CC
- Protect CC using Feeding Buffers
- Try to keep baseline schedule and CC fixed during execution
- Use buffers as proactive warning system during execution

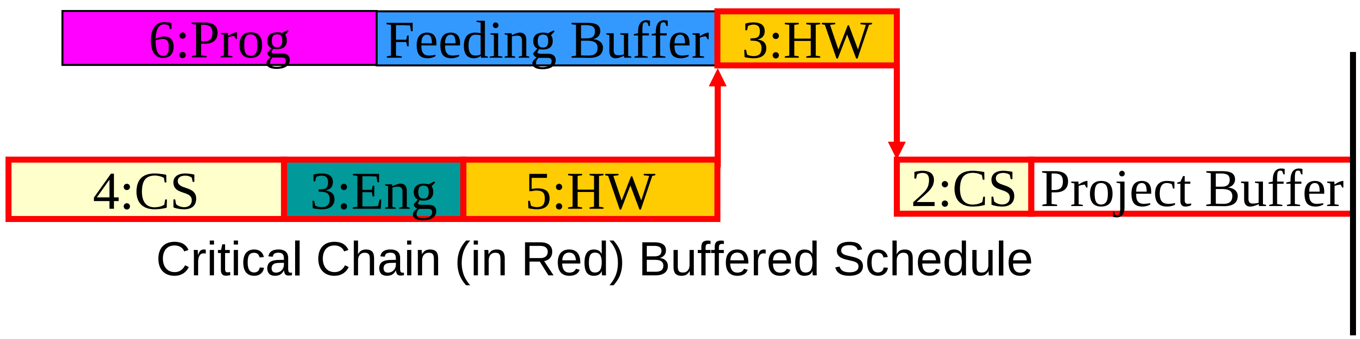
# What is CC?

## Single-Project: Feeding & Project Buffers

### CPM Network




### CC Network




Individual activities are scheduled at their average durations (no safety margin)

15%-25% decrease of project duration

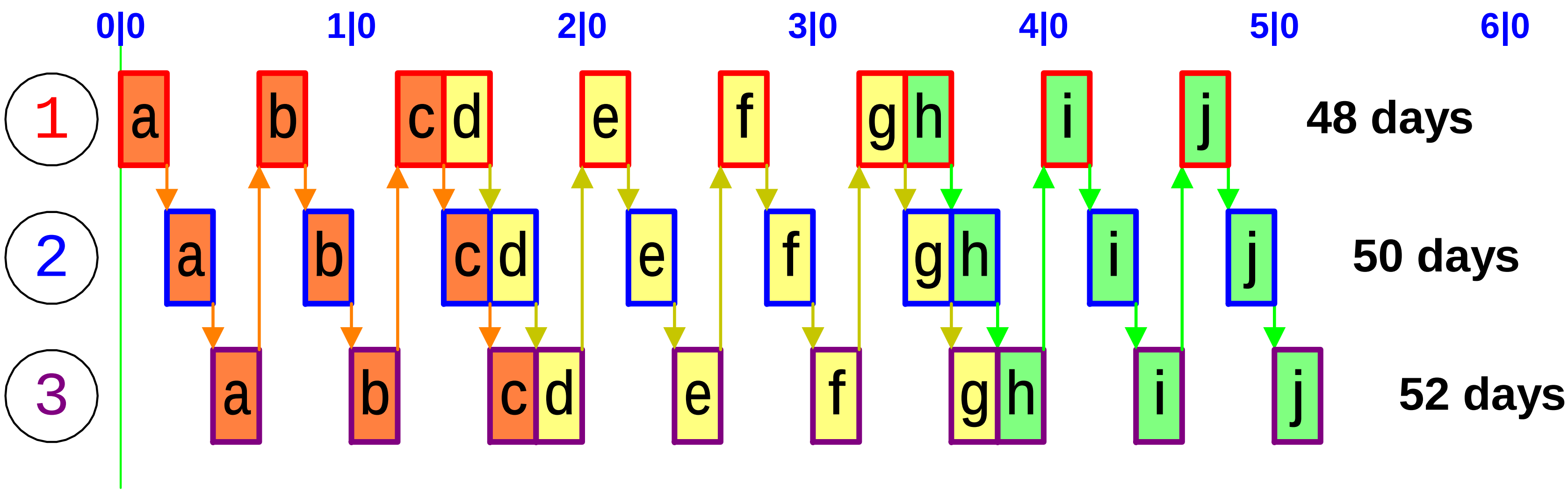
# What is CC?
## Multiple-Project Level

Critical Chain computation steps for multi project scheduling:

- Prioritize projects
- Avoid “bad” multitasking of resources
- Stagger the projects around use of system resource
- Insert drum buffers to ensure full utilization of critical resource
- Measure and report the buffers

# What is CC?

## Multiple-Project: Multitasking Problem




Constraint:

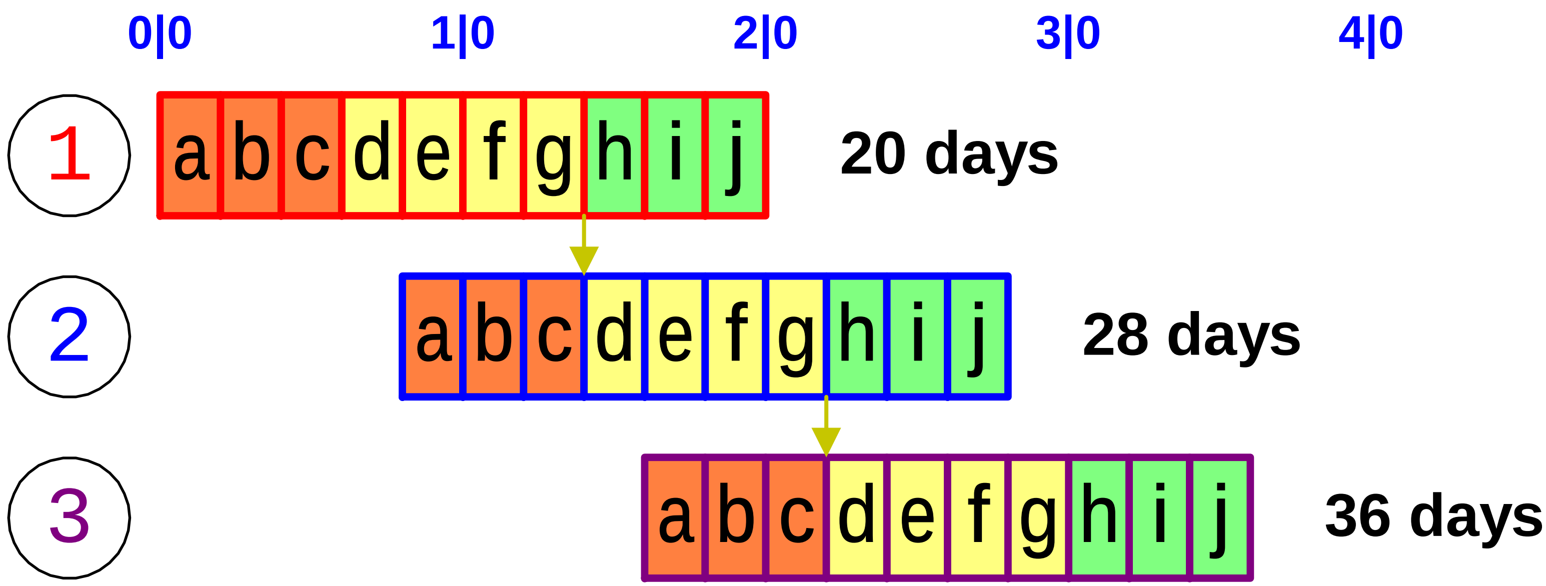
- Limited Resources

Lead-time: all projects take at least 48 days!

No benefits until when?

# What is CC?

## Multiple-Project: Avoid Multitasking




Constraint:

- Limited Resources
- No Multitasking

Lead-time: All projects finish sooner the third after 36 days!

Benefit stream arrives earlier

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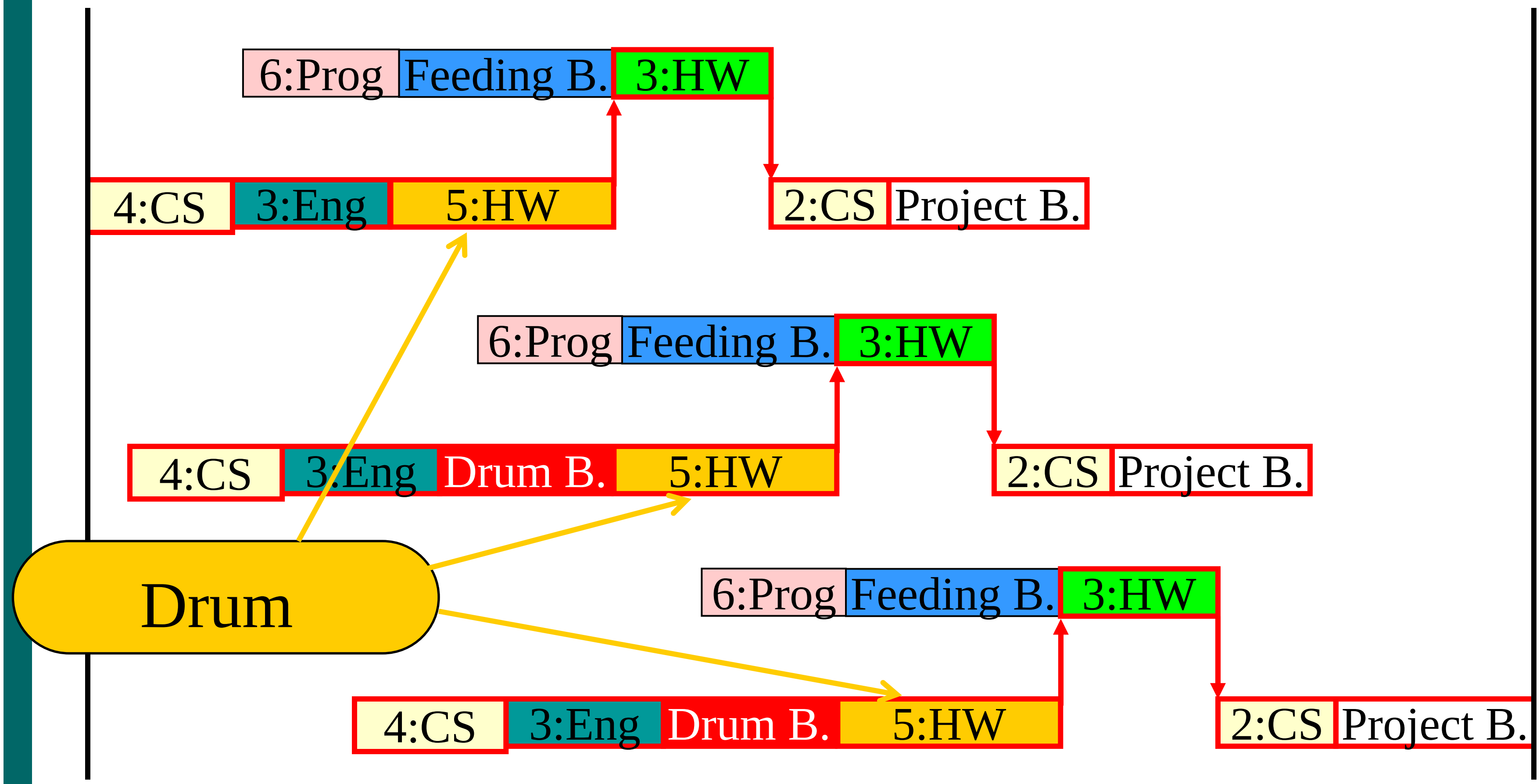
# What is CC?

## Multiple-Project: Drum Buffer Concept



# Critical Chain Advantages

## Reported Critical Chain Improvements

**Question: On-time performance for the projects of my organization is:**

| On-time performance | N | CPM | N | CC |
|---|---|---|---|---|
| Greater Than 90% | 9 | 7% | 8 | 53% |
| 80% To 90% | 12 | 10% | 3 | 20% |
| 70% To 80% | 18 | 15% | 1 | 7% |
| 60% To 70% | 20 | 17% | 0 | 0 |
| 50% To 60% | 18 | 15% | 1 | 7% |
| 40% To 50% | 15 | 12% | 0 | 0 |
| Less Than 40% | 27 | 22% | 0 | 0 |
| No Response | 2 | 2% | 2 | 14% |

Results from: http://www.pdinstitute.com/surveys/surveyresults.htm

**CC promises higher due date performance!**

# CC Performance Impact

## Cross Case Analysis: Selected Cases

| CC-Project | Before | After |
| --- | --- | --- |
| **Warfighter Systems Testing (US Air Force Operational Test & Evaluation Center)** | 18 projects in six months. On time delivery unknown. | 26 projects in six months.<br>75% projects on time;<br>30% reduction in cycle time. |
| **Aircraft Repair and Overhaul (US Naval Aviation Depot, Cherry Point)** | Average turnaround time (TAT) for H-46 aircraft was 225 days.<br>Throughput was 23 per year. | Reduced TAT to 167 days, a 25% reduction while work scope was increasing.<br>Delivered 23 aircraft in six months (throughput of 46 per year).<br>70% reduction in backlog |
| **Submarine Maintenance and Repair (US Naval Shipyard, Pearl Harbor)** | Job Completion Rate = 94%.<br>On-time delivery less than 60%.<br>Cost per job was $5,043. | Job Completion Rate now 98% On-time delivery 95+%.<br>Cost per job reduced 33% Overtime reduced by 49%<br>$9M saving in first year. |

# CC Performance Impact

## Cross Case Analysis: Summary

The Impact of CC across many cases:

- Increased systems throughput ~ 20%
- Reduced project schedule ~ 15% - 40%
- Increased on-time delivery ~ 93%
- Reduced backlog ~ 30% - 70%
- Reduced overtime ~ 20% - 50%

**CC shows dramatic performance improvements but…**

# Case Study ABC Ltd.

## Company profile

- **Size:** $800M sales, 2,500 employees (approx.)
- **Industry**: Aerospace and defense – development and integration of complex systems
- **Project types:** From highly complex to simple sustained engineering projects
  - No routine projects
  - Projects: $10-100 million hardware and software
- **Project management information**:
  - Over 100 concurrent projects.
  - Many external subcontractors about 25% of the work
- **Project Organization:** Mixture of experienced and inexperienced project managers

# Case Study ABC Ltd.

## Success Factors of Implementation

Three main success factors of implementation:

- Top management was highly involved in focusing the organization on project management. The implementation of Critical Chain enabled better prioritization.
- Good project management practices were used across the organization.
- The pilot implementation was carried out in collaboration with AGI (Avraham Goldratt Institute). Full scale implementation was accomplished by an internal management team.

# Case Study ABC Ltd.

## Managing multi-project system with CC

- Each of the professional teams had its own resource bottleneck. No company-wide Drum Buffer!
- Management team discussed priorities every month
- Performance measures monitored by top management:

  Monthly:
  - lead time
  - due-date performance
  - operating expenses
  - capacity utilization (of people, 1600 hours/month)

  Quarterly:
  - throughput
  - cash flow, and additional financial measures.

# Case Study ABC Ltd.

**Planning single projects with CC**

- **Duration Estimate:** Activity/project durations were assessed by the developing teams. They were asked to estimate median times. Estimates were not cut down by management.
- **Project buffer** was determined to be 50% of the corresponding critical chain in each project.
- **Feeding buffers** were sized at 50% of the feeding chain duration.
- **Resource buffers** were not implemented
- **Milestone Buffers** were placed in front of all contractual milestones and were 50% of the "local" critical chain (between milestones)

# Case Study ABC Ltd.

## Controlling single projects with CC

- Resource team managers assigned the available developers to their next task "on the fly".
- In case of large delays in the project, where the project buffer was consumed, usually rescheduling was performed.
- The following **performance metrics** were reported and monitored monthly :
  - buffer consumption
  - effective buffer (what is left at any time)
  - buffer trend (penetration rate)
  - quality: number of ECR’s, meeting requirements, no. of cycles

# Case Study ABC Ltd.

## CC-Performance Impact

| Metrics | After CC implementation |
|---|---|
| Project delay | Less than 2 weeks in all projects |
| Project throughput | 20-30% annual increase |
| Projects in pipeline/ projects selected | No change |
| Project outcome quality | Substantially improved |
| Resource utilization | No change (always worked 100%) added more projects) |
| Resource overtime | No change |

**Significant performance improvements! But…**

# Case Study ABC Ltd.

**CC-Problems and lessons learned**

**CC related problems:**

- Difficulty in persuading developers to use 50% estimates
- Managers' tendency to cut the remaining duration in case of delays, instead of solving the root problems.

**"Bad Multi-Tasking"**

- Number of open tasks per worker was measured for several months with good effect (max 3 to 4 at the same time - prior was to 10-20 activities).
- Later on, this measurement was discontinued and, in hindsight, this was a mistake.
- Feeding buffers: Implemented but not necessary

**Classic CC-Concept too complex!**

# Case Study ABC Ltd.

## CC-Critical Success Factors/Lessons

**Critical success factors of implementation**

- Top management championship
- Clear definition of goals and objectives
- Professional IT support
- Clear role definition
- Existence of "knowledge centers" in the organization
- Milestone buffers

**Lessons Learned**

- Must achieve suppliers' and internal customers' understanding of the rational of the critical chain methodology and the resulting cooperation
- Not all buffers necessary
- Local vs. global constraint resource

# CC Implementation Problems

## Failure Case Company “T”

**Background**

- **A 600 people division, part of a 1500 employee company**
- **Telecommunication, mainly software development projects**
- **Fully owned by a public NYSE company**
- **Crisis situation, main customer cut orders by 50%**
- **“Bubble” and “bubble explosion” time (2000)**
- **Pilot project using CC 60-70 people for two years**

# CC Implementation Problems

## Failure Case Company “T”

**Implementation: The 3-Tier Model**

**Tier 1 – Focused Management**

- **Top management and division management went through TOC and Focused Management training and philosophy**
  - **Effective strategic gating using the 25/25 rule reduced project load by 20%**
  - **A development roadmap established**

# CC Implementation Problems

**Failure Case Company “T”**

**Implementation: The 3-Tier Model**

**Tier 2 – Project Management**

- **The company had good tradition of Project Management methodology and practices over years. Considered a good project-oriented company in the industry**
- **Stage-gate model used for several years**

# CC Implementation Problems

## Failure Case Company "T"

**Implementation: The 3-Tier Model**

**Tier 3 – CC Implementation**

- **Training of division management**
- **Starting with a large pilot 60-70 people project**
- **Re-planning the project – content and time-table led to useful results:**
  - **Reducing activities time by choosing different alternatives**
  - **Reducing subcontractors and suppliers' prices**
  - **Previously seen as a technical problem – now management got involved and found out that some activities could be eliminated**

# CC Implementation Problems

**Failure Case Company “T”**

**Implementation: The 3-Tier Model**

**Tier 3 – CC Implementation (cont.)**

- **Resistance from project team to reduce more than 10% of activities’ time**
- **Resistance from project team to use feeding and project buffer management**
- **Use of a dedicated CC software package caused problems in coordination with the existing, relatively new package and company’s procedures**
- **Crisis time – pressure to cut staff**

# CC Implementation Problems

**Failure Case Company “T”**

## Epilog

- CC abandoned after 8 months
- CC software was not used
- People think CC does not fit their needs
- Perceived no big potential for improvement

# CC Implementation Problems

**Failure Case Company "T"**

**Epilog**

- **Benefits included:**
  - **implementing the 25/25 concept**
  - **Redesigning the project**
  - **Better focusing and managing the bottleneck (system engineering)**
- **Better communication**
- **Ability to finish the project with 20% less people that had to be laid off**

# CC Implementation Problems

**Failure Case Company "T"**

**Epilog (cont.)**

**Causes for failure:**

- **Not enough management attention because of the economic crisis**
- **Too complex to manage - too many buffers**
- **Failure to meet 50% designed activities' length – aspiration tool low**

# CC Implementation Problems

## Failure Case Company “T”

**Lessons learned**

- **Need 100% top management attention**
- **Need more than 10% lead time reduction at the planning stage**
- **CC concept too complex:**
  - **Too many buffers**
- **Focused Management techniques and TOC education, especially the 25/25 rule, redesigning the project, and focusing on Bottlenecks are very beneficial**

# CC Implementation Problems

## Summary

Several CC implementation failures are known but not published!

**Common problems:**

- Too complex (six different buffers)
- No existing PM standard
- Lack of senior management buy-in
- Not a company-wide process
- Not focused
- Behavioral issues (50% estimates)

# CC Implementation Concept

## 3 Tier Implementation Model

**Critical Chain**

Successful Implementation

**Focused Management**

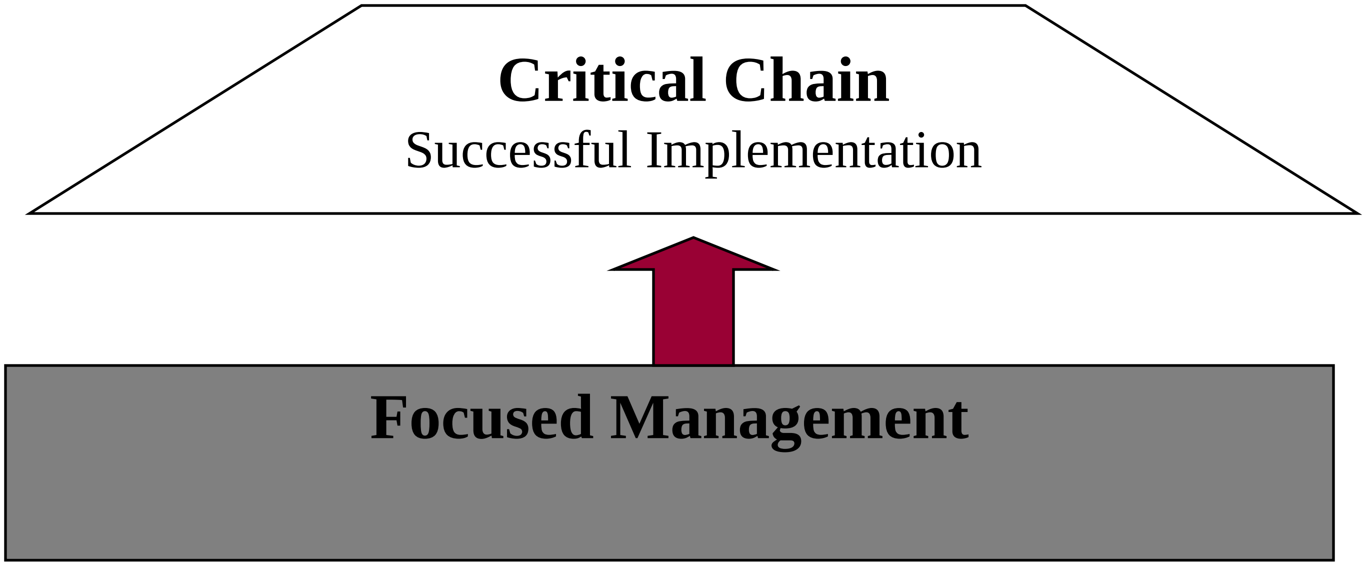
**Project Management**

Plan, Staff, Organize, Coordinate, Communicate, Educate

PMBoK, NASA 7120.5B

# CC Implementation Concept

## CC without Project Management Standard




Implementation without PM standard leads to:

- Better business results due to better selection of projects and Bottleneck utilization

…But

- No continuation of PM improvement

# Solution *CC-Lite* Research Project

**Conceptual Objectives**

- Follow the Pareto Principal
- Simple approach to buffer management:
  - Minimum number of buffers needed
  - Buffer sizing
  - Buffer control
- Stable and fixed CC
- Simple and effective performance metrics
- Risk focused tool

**Develop *CC-Lite* as a practical and effective CC solution**

# Solution *CC-Lite* Research Project

**An Analogy to ToC in Manufacturing**

**TOC (1985):**

- Assembly Buffers
- Shipping Buffer
- Drum Buffer

Goldratt & Fox (1985) "The Race"

**TOC (2005):**

- Shipping Buffer
- And, in a few cases – Drum Buffer

**Practice showed not all concepts were necessary!**

# Solution *CC-Lite* Research Project

## Simplifying the Approach

**CC (1996):**

- Feeding Buffer
- Resource Buffer
- Drum Buffer
- Project Buffer
- Milestone Buffer
- Capacity Buffer

***CC-LITE* (2005):**

- Milestone Buffer (Always)
- Project Buffer (Always)
- Drum Buffer (Sometimes)

**In manufacturing, practice showed that not all TOC concepts were necessary!**

# Solution *CC-Lite* Research Project

**Simplifying the Approach**

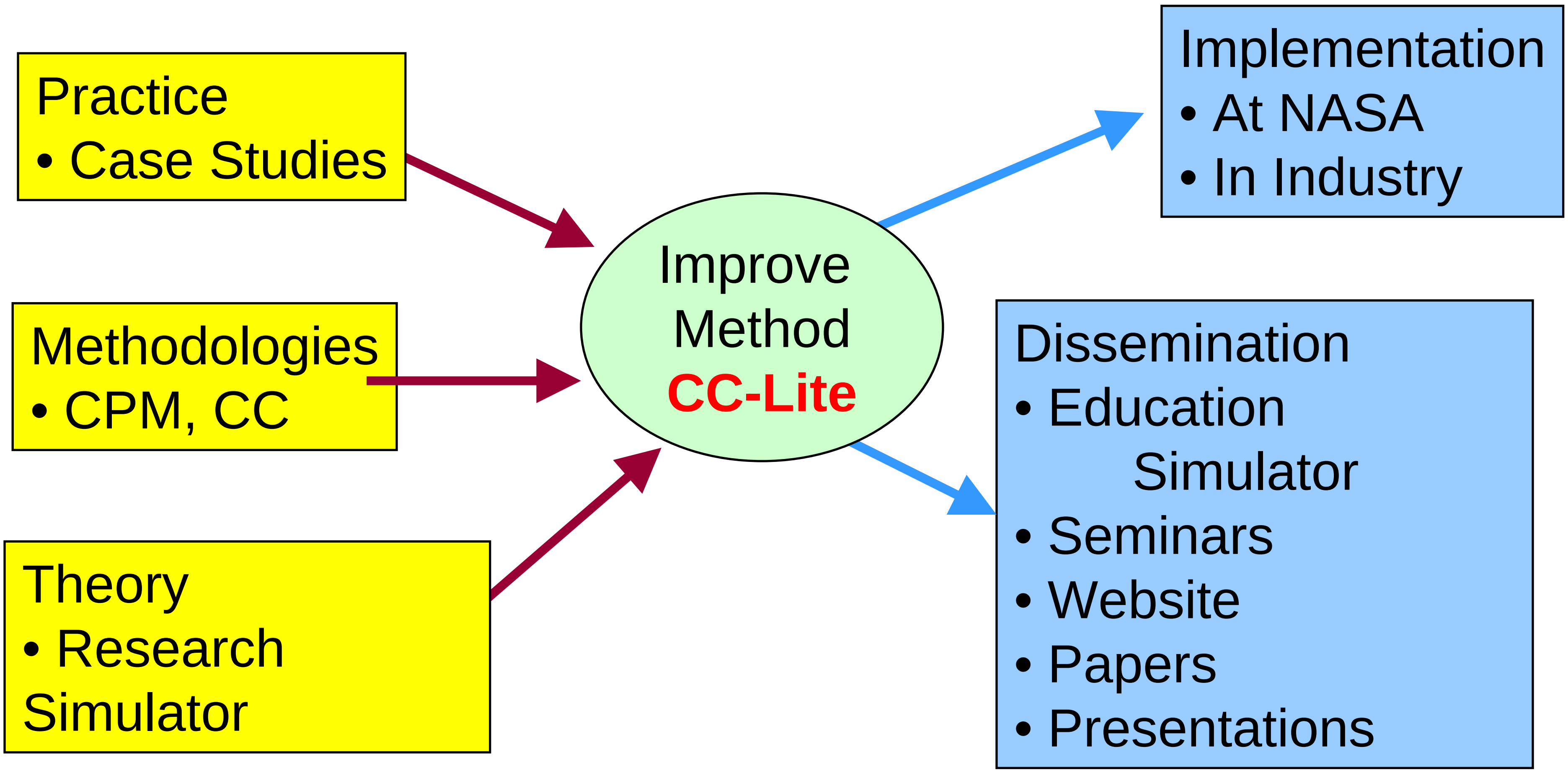
- **Actual Buffer/ Minimum required buffer**
- **Systems throughput of projects**
- **Due date performance (% of milestones finished or mean project duration and its standard dev.**
- **Operating expenses (# of hours invested)**
- **Inventory (amount of work in process not finished yet, hours invested in unfinished work orders/activities)**
- **Project Quality (# development cycles and # of changes)**

**Which metrics are needed?**

# Solution *CC-Lite* Research Project

**Improve the Classical CC-Approach**

**Develop new approaches for improving project schedule and budget performance in a multi-project environment.**



# Solution *CC-Lite* Research Project

## Project Activities

1. Interviews/case studies of resource allocation practice using CC concepts in commercial applications
2. CC-Lite Educational Simulator
3. CC-Lite Research Simulator
4. Preparation of CC Seminar(s) for NASA
5. Two papers in progress

# What Can NASA Learn?

- Is there a need to significantly improve?
- Is there an ability to make a paradigm shift change?
- Do easy things first:
  - TOC and focused management training, 25/25, strategic gating
- Project Management ability
- CC-Lite

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# Questions

- Questions
- &
- Comments?